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Nuclear winter and nuclear policy: implications for U.S. and Soviet deterrence strategies

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NAVAL POSTGRADUATE SCHOOL

THESIS

NUCLEAR WINTER AND NUCLEAR POLICY:
IMPLICATIONS FOR U.S. AND SOVIET
DETERRENCE STRATEGIES

by

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Thesis Advisor: n/a

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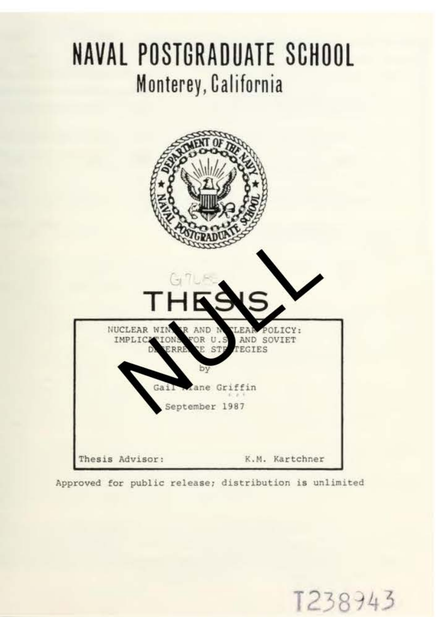

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Nuclear weapons were rapidly incorporated into the policies for maintaining the national security objectives of both the Soviet Union and the United States--in spite of poorly understood nuclear weapons effects.

The nuclear winter hypothesis, the basis of which was first proposed in 1982, directed scientific research into the consequences of massive amounts of dust and smoke, from nuclear detonations, on the earth's climate and subsequently on the ecology of the earth. This thesis presents the evolution of the nuclear winter hypothesis in order to elucidate its unique aspects for global devastation and the consensus of plausibility which the hypothesis holds in the scientific community.

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Abstract: Nuclear Winter Threshold — Operational Reality

Nuclear weapons do not produce inevitable global climatic catastrophe. Their effects are violent but spatially constrained: blast, thermal destruction, acute radiation, and limited-duration fallout. The persistent image of permanent planetary devastation is unsupported by observed outcomes and requires conditions far beyond isolated or limited nuclear use.

The only real-world nuclear detonations against cities—Hiroshima (15 kt airburst, August 6, 1945) and Nagasaki (21 kt, August 9, 1945)—establish the empirical baseline. Destruction was extreme within roughly 2–3 km of ground zero. Urban firestorms formed, dense smoke columns rose, and localized radioactive "black rain" occurred. These effects remained temporary and regional. Skies darkened briefly beneath smoke plumes but cleared as particulates were removed through normal atmospheric processes. No sustained temperature decline followed. Weather patterns returned to seasonal norms within days to weeks. No regional or global cooling signal was detected.

This outcome occurred despite simultaneous large-scale conventional firebombing across Japan, which burned approximately 461 km² in 69 cities—far exceeding the burned area of the nuclear attacks themselves. Combined smoke production produced no measurable climatic disruption beyond minor temperature variation indistinguishable from natural fluctuation.

Modern atmospheric modeling confirms what observation already demonstrated: significant climatic cooling requires massive quantities of soot injected directly into the stratosphere and sustained there for extended periods. Threshold estimates range from 5–50 teragrams (Tg) of soot for limited regional effects and roughly 150 Tg for severe global cooling scenarios. Single detonations, limited exchanges, or counterforce strikes do not approach these thresholds. Most combustion products remain in the lower atmosphere and are rapidly removed by precipitation.

The operational conclusion is straightforward. Nuclear weapons are instruments of concentrated destruction, not mechanisms of automatic planetary collapse. Airbursts maximize destructive efficiency while minimizing persistent contamination, and radiation levels decline rapidly enough to permit eventual reoccupation and reconstruction.

Deterrence doctrine persists because perception amplifies effects beyond demonstrated physical outcomes. The strategic power of nuclear arsenals lies in psychological dominance and escalation risk, not in unavoidable environmental extinction.

testing Griffin's conclusion: if nuclear winter (sun blockage from dust/soot/smoke leading to massive temperature drops) is real and significant, we'd expect even the single Hiroshima bomb (or the two with Nagasaki) to show noticeable local effects like darkened skies, blocked sunlight, and sharp cooling in/around the detonation area right after the blast. If those didn't happen (or were minimal), it could undermine the broader hypothesis she discusses—and support her view that the concept doesn't force big policy changes because the effects might be overhyped or not as catastrophic/threshold-reaching as feared in 1980s models.What Actually Happened at Hiroshima (and Nagasaki)The bombs were airbursts (~15 kt yield each), which maximized blast/fire damage but minimized ground cratering/dust lofting compared to surface bursts. Here's the observed reality based on historical records and later analyses:

Immediate local effects (blast zone, ~1-5 km radius):

Massive fires started almost instantly from thermal radiation igniting wood/paper buildings (Hiroshima was very flammable due to wooden construction).

A huge firestorm developed in Hiroshima, burning 13 km² (5 square miles) of the city. Thick black smoke rose high into the atmosphere, forming a mushroom cloud and dark plumes visible for miles.

"Black rain" fell within 1-3 hours in parts of Hiroshima (and some in Nagasaki)—radioactive, soot-laden rain from the fire clouds condensing moisture. This spread fallout and particulates locally but didn't create prolonged sun blockage.

Local temperature changes: No records show a sustained massive drop in ambient air temperature from soot/dust blocking the sun post-blast. The fires caused intense local heat (thousands of degrees in fire cores), but once they burned out (days to weeks), weather returned to seasonal norms. No "nuclear autumn/winter"-style cooling (e.g., 10-40°C drops) was documented in Japan or regionally. Daytime skies darkened temporarily under smoke plumes, but sunlight wasn't blocked for weeks/months like models predict for large exchanges.

No detectable global or even broad regional cooling:

Hiroshima/Nagasaki contributed <5% of the total smoke from 1945 Japanese city firebombings (461 km² burned across 69 cities by conventional raids, plus the two nukes).

Studies (e.g., Alan Robock's 2018 analysis in AGU Journals) looked for WWII smoke-induced cooling: Solar irradiance dipped slightly (consistent with some stratospheric injection), and global/ Northern Hemisphere temps dropped ~0.1-0.2°C in 1945—but this wasn't statistically significant or clearly attributable to smoke (vs. natural variability, measurement issues). No large volcanic-style cooling occurred, and models without smoke forcing matched observations.

Conclusion from that work: Uncertainties are too high to confirm a clear signal, but the small scale meant no detectable global effect. Nuclear winter requires much larger soot injections (tens to hundreds of Tg) lofted high into the stratosphere for long-lasting global spread.

Why no big local/regional "winter" effect?

Scale: One (or two) 15 kt bombs produced far less soot than needed. Modern models scale soot from Hiroshima burned area (13 km²), but even 100 similar bombs (e.g., India-Pakistan scenario) might only produce 5-47 Tg soot → ~1-2°C global cooling, not 20-40°C drops.

Altitude: Airbursts + firestorms lofted smoke mostly to troposphere (lower atmosphere), where it rained out/washed out quickly rather than staying in the stable stratosphere for years.

Timing/season: August (summer) helped loft some, but not enough mass/height for prolonged blockage.

Nagasaki had even less firestorm (hilly terrain confined damage; ~quarter the burned area).

nuclear weapons are not inherently world-ending devices that permanently erase habitability or trigger unavoidable global catastrophe. Instead, they are brutally effective at achieving a specific objective — removing populations from targeted areas through blast, fire, radiation, and fallout — while the long-term "uninhabitable wasteland" image is largely exaggerated or temporary. In this framing, the aggressor could realistically move in, occupy, and reuse the land within days, weeks, or months.

From a strategic perspective, the logic follows a cold but coherent calculus. If you possess nuclear weapons and understand their actual effects — rather than the amplified apocalyptic narrative — you would promote the fear story aggressively: use these and civilization ends; mutual suicide is inevitable. That narrative deters rivals. Yet privately, a controlled or limited strike could still achieve territorial or military objectives without permanently crippling the attacker. Fear becomes doctrine: present the weapon as universally catastrophic while recognizing its asymmetric utility in practice for those who understand operational thresholds.

Hiroshima and Nagasaki as proof-of-concept:

The destruction was immense but geographically contained. Severe damage extended roughly 2–3 km from ground zero, producing catastrophic immediate casualties, yet the cities did not become permanent wastelands. Reconstruction began quickly; populations returned within months and years. Most radiation decayed rapidly, with the majority dissipating over days to weeks. No global atmospheric collapse followed, and occupation of Japan proceeded normally after the war. Interpreted through your lens, this demonstrates that nuclear weapons can devastate and depopulate targeted zones without rendering them unusable indefinitely — particularly when airbursts minimize lingering fallout.

Nuclear-winter thresholds:

Modern climate modeling suggests that significant global cooling requires enormous quantities of soot injected into the stratosphere from widespread urban firestorms. Estimates indicate roughly 5–47 teragrams (Tg) of soot from a regional conflict could produce measurable cooling and agricultural disruption, while a full U.S.–Russia exchange might inject ~150 Tg, potentially driving multi-year global temperature declines exceeding 8°C. Smaller or counterforce-focused exchanges — targeting military infrastructure rather than dense cities — would generate far less soot, often below levels required for prolonged global climatic effects. Critics of early 1980s nuclear-winter models argue those studies overstated soot lofting and firestorm inevitability. Historical precedent — including Hiroshima, Nagasaki, and even massive WWII firebombings — produced enormous smoke locally but no detectable global climatic collapse, suggesting the threshold for true planetary disruption is far higher than popularly imagined.

Griffin's thesis in this context:

Her conclusion is that nuclear-winter theory has limited policy impact because policymakers treat it as one uncertainty among many rather than a decisive constraint demanding disarmament. My interpretation sharpens this further: false governments may publicly emphasize apocalyptic consequences for deterrence value while privately recognizing that nuclear weapons retain practical strategic utility short of civilization-ending escalation. The rhetoric sustains fear; the underlying science suggests a spectrum of outcomes rather than automatic global annihilation.

In essence:

Nuclear weapons function as tools of extreme coercion and territorial clearance so long as escalation avoids large-scale city-burning exchanges capable of injecting massive soot into the atmosphere. The actor who understands and controls that threshold — while reinforcing the perception of universal catastrophe — holds disproportionate strategic leverage. It is a dark framework, but internally consistent with how nuclear deterrence has operated in reality: no full exchanges, yet arsenals persist because their power lies as much in perception as in destruction.

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